Behaviour of steel pipelines with composite repairs analysed using experimental and numerical approaches

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ABSTRACT

Over long service periods, pipelines are subjected to deterioration and damage, which can reduce their strength and structural integrity. Repair mechanisms have been developed for restoring the loading capacity of damaged pipelines; in this context, composite-repair systems have become popular over the past few years. The material properties of the repair system components (putty and composite wrap) are critical in designing the repair and understanding the behaviour of a composite-repaired pipe. In this study, the mechanical properties of steel pipe, putty, and composite wrap were investigated individually through laboratory tests. The behaviour of all the materials is discussed to understand their response under various loading conditions. The steel pipes showed the highest tensile strength and modulus. The composite wrap shows better performance during tensile testing than during compression testing. Meanwhile, the putty recorded superior compressive properties as compared to its tensile and flexural properties. The steel pipe shows ductile behaviour while the putty and composite wrap exhibit brittle behaviour. The study was then followed by full-scale pipeline burst tests and finite element analyses on a defective pipe and a composite-repaired pipe. The results show that the burst pressure of the composite-repaired pipe increased by 23% and it experienced significantly reduced strain in the defect region. Detailed information on the burst pressure and strain reading over the entire applied pressure range was recorded for all the components of the burst-test specimens and their behaviour is discussed to achieve a better understanding of composite-repaired pipes. These findings can be very useful in the optimising the existing composite repair design procedures.

KEYWORDS

Burst test; Composite repair; Finite element analysis; Mechanical properties; Pipeline

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